

Panel Data Analysis Of The American Recovery And Reinvestment Act

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Abstract

The proposed study seeks to evaluate the merits of the American Recovery and Reinvestment Act of 2009 (commonly referred to as the “stimulus”) against its trifold objectives of: (a) creation of new jobs and protection of existing ones; (b) promotion of economic activity and sustainment of long-term growth; and (c) implementation of accountability and transparency in government spending. In a previous cross sectional analysis conducted by the authors, the stimulus provided by the government was found to have no effect on the housing prices. Therefore, the utility of the Act is questionable. In the current study, we look at one of the three modes in which the Act attempted to achieve its objectives and analyze it in depth. The analysis uses a 8-year panel data set across all 50 states in the United States. Results obtained from this analysis are expected to increase the efficacy of the implementable policy measures to ensure that the objectives and the results of the policy conform in similar future situations.

INTRODUCTION

The housing market crash is considered the primary cause of the 2007-2009 recession in the United States. This recession was the worst one in the history of the U.S. since the Great Depression of 1930s (IMF 2009). In response to it, the federal government was forced to provide almost \$1 trillion in stimulus packages and the Federal Reserve had to print \$600 million to maintain liquidity (Mian, and Sufi 2014). The stimulus package provided by the Obama administration was named the American Recovery and Reinvestment Act (henceforth, referred to as the Act). These bailout programs shifted the liabilities from private hands to the government on a scale that had never been seen before (United Nations 2013). The Act had three purposes (Civic Impulse 2015):

1. To create new jobs and save the existing ones
2. Spur economic activity and increase investment in long term growth
3. Foster unprecedented levels of accountability and transparency in government spending

As apt as these objectives might seem given the situation at hand, back tracking leads to a different story. In previous research on the same topic, we discovered that the Act had little to no impact in affecting the house prices in a state-level cross-sectional analysis when a variable of foreclosure rates was included in the econometric model. In fact, the analysis went as far as to suggest that if no stimulus had been provided, the duration of the recession could have been shorter, thus implying that the stimulus could have been counterproductive (Sullere, Liang, and Ondracek 2014). Since the fall in housing prices was the root cause of recession, this motivated us to analyze whether the Act had any benefit on the entire economy, or not. In other words: Was the Act able to meet its objectives?

Research (Zacharias, Masterson and Kim 2009) has found that the responses to the recession (the Act) were not able to curtail the rapid growth in the income inequality that could have occurred due to the recession. The rich got richer while the wage growth of the lower income group stagnated. The only area where the Act was able to increase the number of jobs was in the public sector (Conley and Dupor 2011). There were 450,000 public sector jobs created by the Act. This growth, sadly, was accompanied by a massive hit in the private sector as it resulted in the destruction or forestalling of more than a million jobs. Some econometric research (Conley and Dupor 2013) also argues that the number of jobs created in the public sector was in fact between 156,000 and 563,000 after accounting for endogenous variables in the model, while the loss was barely 182,000 jobs. However the cost of creating and sustaining a single job for an entire year was as high as \$202,000 (much higher than the salary paid to that worker). Creation (without sustainment) of barely a single job required a sum of \$170,000 (Feyrer and Sacerdote 2011). In the same paper a time series analysis also suggested that a gross spending of \$400,000 was required to create an additional job. Other research (Chodorow-Reich et al. 2012) uses a similar study and comes up with the hypothesis that in the first year of the Act about 8 jobs were created for every million dollars that were spent by the Act.

However, until now no research has been conducted to implement an unemployment model into a time series analysis. Neither have econometric forecasting techniques been implemented to develop separate models to get a quantitative and comparative sense of the how the Act was

implemented. Other important factors which have still not been studied include the time it took to return to the natural rate of unemployment and a long term analysis (including years leading to the recession and recovery years). In our research we will be using all of these aspects, which have been missed till now, to analyze the long term impact of the American Recovery and Reinvestment Act of 2009.

LITERATURE REVIEW

There is an abundance of research pertaining to the evaluation of the American Recovery and Reinvestment Act (henceforth referred to as ARRA). We discuss the papers on which we base our analysis. The existing research provides an invaluable insight into the execution and implementation of ARRA, with intricate details on fungibility, spillovers, health, education, etc. While these papers provide a wealth of data and analysis, they do not evaluate the ARRA against the objectives that it had set to accomplish.

The main issue that weakens the claim that ARRA was effective is fungibility (Conley and Dupor 2013). Since the ARRA spending was largely a stimulus to state and local governments, the funds were channeled through these respective governments. This channeling led to three consequences:

1. *Bias in job creation*: Since the money was allocated to the government, the rise in the number of jobs was seen in the government sector and not in the private sector. This could also indirectly imply that people who gained jobs in government sector were not new workers, but merely workers laid off by the private sector.
2. *Differential spending*: This channeling of ARRA aid through the state and local governments creates the possibility of differential aid allocation depending on varying characteristics of the states. For example, the states facing worse conditions were given a larger share of the stimulus.
3. *Fungibility*: Channeling ARRA funds through the state and local governments created the condition that the funds might be used to substitute the state and local governmental spending. This is the issue of fungibility. Mathematically, it is defined in the following way:

$$\begin{aligned} \text{EmploymentGrowth} &= \alpha \text{ aid} - \beta \text{ loss} + \gamma \text{ other} + \epsilon \\ \alpha \text{ aid} - \beta \text{ loss} &= \text{offset} \end{aligned}$$

ARRA had specified certain sections that would be solely for state government's use like the State Fiscal Stabilization Fund program, Medicaid program, etc. However, the state and local governments received funds at a time when the governments were facing a budget crisis due to reduced tax revenues and increased expenditure on recession-oriented programs. Therefore, there was a substantial incentive in place for state and local governments to use the ARRA funds to pay for the routine operations of the government.

The paper's findings suggest that relative to a no stimulus baseline, ARRA spending did affect government employment (Conley and Dupor 2013). However, in the private sector the effect was not statistically different from zero. This paper concentrates solely on funding received by the

Department of Transportation across states and how it was allocated for highway improvements for its data source and therefore had a limited span. Additionally, there is a Spillover Effect. Spillover effect means that neighboring states usually observe some benefits from increase in spending in the bordering state. This is especially true for highways and network commodities. This paper lacks critically in accounting for spillovers, which will be a major focus of our paper.

There exists a split in literature regarding employment generation as a result of the Act. Some claim that the total amount of money distributed through this program is large enough to plausibly generate a detectable effect on employment (Chodorow-Reich et al. 2012). The paper while being a cross sectional analysis lays out similar claim of the funds being fungible. However it does bring forth another challenge. The amount of aid a state receives is endogenous to the state's economic conditions. Since the states in worse economic shape received more aid, the Ordinary Least Square relationship between the levels undermines the true effect of state relief. Thus, the parameters are biased downwards. This paper includes a number of additional variables that affect unemployment like health and education. Additionally, it groups states into six discrete categories for easier analysis. The paper also suggests that a marginal \$100,000 in Medicaid transfers resulted in 3.8 net job-years of total employment through June 2010. However, this paper concentrates solely on Medicaid and pursues a cross sectional analysis. It does raise a few important questions regarding the role of government in providing revenue to states during recessions and trade-off between providing relief and critical budget situations leading to perverse incentives for the policy makers.

On the other hand, there exists research which surprisingly finds either negligible or negative effects of the Act on total employment (Conley and Dupor 2011). This paper attempts to account for cross-state positive spillovers. It claims that if the spillover from interstate trade is widespread nationally, then the nationwide effect on jobs by ARRA may be larger than what has been found. To address this, the authors add time series variation to the cross-state variation. They start their analysis in mid-2009. They lack a sufficiently long time series to present in their paper. Additionally, their research demands better structure in their economic modeling. They chose the 'model-free' approach for on the government program and data set. This implies that they will only be able to hypothesize the underlying economic mechanisms that provide them with their findings. We will be implementing economic modeling in our research.

There is research (Wilson 2012) that focuses on the spillover effects, which are an integral part of our paper. It claims that the multipliers estimated from cross-sectional studies may be larger than a national multiplier because of the independence between the geographic allocation of federal spending and the geographic allocation of the financing of that spending. This indirectly implies that taxpayers throughout the nation will pay for the funding received in any region. In this sense, cross-sectional studies provide estimates of the multiplier associated with government spending which could have a higher or lower short-run multiplier than that of deficit-financed spending. The paper uses both observed data on macroeconomic outcomes (employment) and observed data on actual ARRA stimulus spending. This paper also exploits the cross-sectional, geographic variation in ARRA spending to estimate its economic effects. The results of this paper imply that in its first-year, ARRA spending yielded about eight jobs per million dollars spent, or about \$125,000 per job. This is again very different from the previous papers due to consideration of spillover effects. At the national level, the estimates imply ARRA spending created/saved about

2.1 million jobs, or 1.6 percent of pre-ARRA total nonfarm employment, in the first year. The estimated employment effect was estimated to have grown further over time, reaching 3.4 million (based on announced funds) by March 2011.

Clearly, studies lack a panel time-series analysis, which will be the focus of our research. Additionally, none of the papers account for spillover effects completely, whereas it is an integral part of our research. We approach the issue of fungibility from a different perspective by looking at the end recipient funds that were allocated as a result of ARRA. We do not focus much on individual explanatory variables but rather base our analysis on a larger macroeconomic model. These differences enable us to answer the standing question of whether the American Recovery and Reinvestment Act has fulfilled the objectives for which it was conceived or not.

METHODS AND DATA

Our analysis uses two models based on Okun's Law. Okun's law in its difference form is given by the following equation:

$$\%Y = \frac{Y_t - Y_{t-1}}{Y_{t-1}} = c(u_t - u_{t-1}) = c(\Delta u_t)$$

where Y_t refers to the GDP in period t , u_t refers to the unemployment rate in the time period t and c acts as a constant of proportionality. We concentrate our analysis at the state level, and therefore we use GSP (Gross State Product) in place of GDP. Additionally, the unemployment rate (u) refers to the seasonally adjusted unemployment rate of the state. Therefore, the time-series equation turns into a panel equation given by:

$$\%Y_{i,t} = c(\Delta u_{i,t})$$

However, since we wish to isolate the impact of the stimulus on unemployment, we switch the equation to a simple linear regression model:

$$\Delta u_{i,t} = \beta_{0,i} + \beta_1 \%Y_{i,t}$$

To this equation we add the amount of stimulus *in percent change terms* so that all our dollar values retain the same form. This translates the equation into the following form:

$$\Delta u_{i,t} = \beta_{0,i} + \beta_1 \%Y_{i,t} + \beta_2 \%stim_{i,t}$$

where *stim* implies the sum of the amount provided by the American Recovery and Reinvestment Act in state i till period t . This equation readily provides us with a simple bivariate regression model with the change in average unemployment rate as the main dependent variable and percentage change in total stimulus awarded until quarter t in state i as our main explanatory variable. Change in unemployment rate can easily be attributed to percent changes in GSP of the state concerned and therefore we need to control changes in unemployment by introducing the $\%Y$ variable for state i and quarter t .

However, this leads us naturally into a dilemma. In case of countries, we simply have GDP and unemployment rate of a country. The GDP of a country does not affect the unemployment rate of the neighboring country significantly. However, the same is not the case with states. In the case of states, there may be a situation where installation of a factory or construction of a highway affects the unemployment rate of neighboring states as well. To account for this discrepancy, we generate a proxy for the total GSP of states other than the state i , given by:

$$GSP_{other_i} = GDP_{US} - GSP_i$$

This variable allows us to control for changes in unemployment rate due to changes in GSP in states other than state i . This transforms our bivariate equation into the following multiple equation model:

$$\Delta u_{i,t} = \beta_{0,i} + \beta_1 \%GSP_{i,t} + \beta_2 \%stim_{i,t} + \beta_3 GSP_{other_i,t}$$

Finally, the stimulus was implemented amidst a lot of criticism pertaining to the rising national debt. National deficit can be ascribed to increases by excessive government spending. We wish to see if the stimulus, after accounting for the increase in national deficits was still successful in decreasing the unemployment rate. Although we were unsuccessful in clearly defining the model which accounts for such variable due to lack of data on breakdown of national deficit spending and the division of federal government and state government contribution, we used an elementary multivariable equation for a regression testing to be given by:

$$\Delta u_{i,t} = \beta_{0,i} + \beta_1 \%GSP_{i,t} + \beta_2 \%stim_{i,t} + \beta_3 \%GSP_{other_i,t} + \beta_4 \%(def - stim)_{i,t}$$

The data on unemployment rate is available on a seasonally adjusted quarterly basis via Bureau of Labor Statistics. We have used the data for all fifty states and have averaged 4 quarters for each state to generate an average unemployment rate for state i for period t . After that, we subtract the previous years average unemployment rate to obtain our differenced variable as given by:

$$\Delta u_{i,t} = u_{i,t} - u_{i,t-1} = \frac{u_{i,q_1} + u_{i,q_2} + u_{i,q_3} + u_{i,q_4}}{4} - \frac{u_{i,q-1_1} + u_{i,q-1_2} + u_{i,q-1_3} + u_{i,q-1_4}}{4}$$

The data for unemployment rate covers years from 2005 to 2013. The same time frame will be used for GSP as well. This allows us to capture the one time effect of the initiation of the Act in 2009 as well.

Gross State Product is the output of the state and is obtained on a quarterly time frame via Bureau of Economic Analysis. The data ranges from 2005 to 2013. It is seasonally adjusted and then averaged in a method similar to the averaging of the unemployment rate.

The data on stimulus is obtained via the Funds Received section from the Recovery.org website. This data provides us with amount of stimulus that was received by a particular state for a project in a particular quarter as well as the sum of the stimulus up until that quarter. This provides

us with an excellent representation for the amount of funds that is received by states. Finally, the national deficit data is obtained via the Department of Treasury. We have used the data that has been revised a year later to remove any discrepancies that may have been present during the preliminary accounting process.

Descriptive statistics are provided in Table 1. They clearly demonstrate the range of our data in the form that we use. Note that the $\%(def - stim)$ is negative to account for the fact that it is a deficit. Therefore, the interpretation of the coefficient should be conducted with that in mind.

Variable	Obsv.	Mean	Standard Deviation	Min	Max
Δu	1785	.0446872	.5023295	-5.366667	2.766667
$\%stim$	1785	.0705679	.1804188	-.3334888	2.469452
$\%GSP$	1785	.0036028	.0141916	-.0662268	.0942488
$\%GSPother$	1785	.0031555	.0066959	-.0241179	.0142906
$\%(def - stim)$	1785	-.3818082	1.581254	-7.280091	1.633896

Table 1: Summary Statistics

The data was checked for Gauss-Markov assumptions. The assumptions remain unviolated. The model does not show any logarithmic or exponential properties with the data factored into consideration. Additionally, variance amongst our data points exists with no change over time and the statement for zero conditional mean ($E(\epsilon) = 0$) for a given x holds.

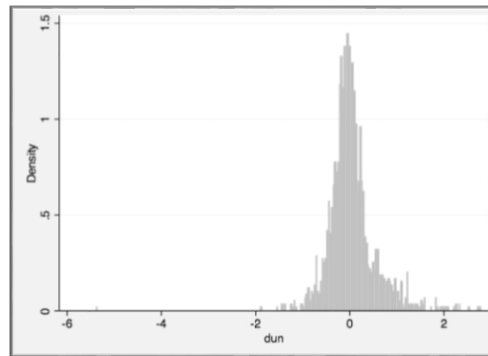


Figure 1: Normal Spread of Change in Unemployment Rate

Even though high correlations exist between the dependent and the explanatory variables, there is no perfect collinearity. Furthermore, the direction of collinearity agrees with the expected behavior. For example, change in unemployment correlates to a negative percent change in Gross State Product. The correlation matrix is provided as follows:

Correlation	Δu	%stim	%Y	%GSPother	%(def – stim)
Δu	1				
%stim	-0.0855	1			
%GSP	-0.2815	0.053	1		
%GSPother	-0.4863	0.1955	0.3688	1	
%(def – stim)	-0.1354	0.1112	0.002	-0.0191	1

Table 2: Correlation Matrix

RESULTS

We run linear panel OLS models on our data across the fifty states. We choose the years for our analysis to range from 2005 to 2013 due to the rationale mentioned in the previous section. Since we are working with quarterly data, this time series provides us with a reasonably large sample size ($n = 1800$) and thus we can comfortably invoke the benefits of normality in our data as shown by the normal density distribution of the change in unemployment rate (Figure 1).

We run two regressions given by:

$$du_{i,t} = \beta_{0,i} + \beta_1 \%Y_{i,t-1,t-2} + \beta_{2...k} (\sum x_{i,t-1}) + \epsilon_i$$

$$du_{i,t} = \beta_{0,i} + \beta_1 \%Y_{i,t-1,t-2} + \beta_{2...k} (\sum x_{i,t-1}) + \beta_{k+1...k+4} \%stim_{t-1..t-4} + \epsilon_i$$

We improve this model further by adding successive lags for our dependent variables and evaluating the model with a random effects specification to account for independent distribution in states. The bivariate regression is our Model (1). Change in unemployment rate, after being controlled for the percentage change in GSP (as per Okun's Law) has residuals that vary with the stimulus spending as given by the Equation (1):

$$\Delta u_{i,t} = \beta_0 + \beta_1 \%GSP_{i,t} + \beta_2 \%stim_{i,t} + \epsilon \quad (1)$$

We then move onwards to utilize all the variables with lag structure so as to understand the delay in the effects of GSP, GSP of other states, stimulus, and the difference in national deficit due to added stimulus on change in unemployment rate as given by Equation (2). We assume that there will be high multicollinearity and the results will not be sound, but we use this model solely for analysis purposes.

$$\Delta u_{i,t} = \beta_0 + \sum_{k=1}^2 \beta_k \%GSP_{i,t-k+1} + \sum_{l=3}^4 \beta_l \%GSPother_{i,t-l+3} + \sum_{m=5}^9 \beta_m \%stim_{i,t-m+5} + \sum_{n=9}^{10} \beta_n \%(def - stim)_{i,t-n+9} + \epsilon \quad (2)$$

The model with lags in our explanatory variables serves as our Model (2). And the final model removes $\%(def - stim)$ from consideration. This is done as $\%(def - stim)$ was just meant to provide us with insight rather than explain the change in unemployment rate.

Variable	(1)	(2)	(3)	(4)
$\%stim$	-.197 (.063)***	0.187 (0.0551)***		
$\%stim(-1)$		0.271 (0.0558)***		
$\%stim(-2)$		-0.314 (0.0570)***	-0.26 (0.053)***	-0.347 (0.055)***
$\%stim(-3)$		-0.230 (0.0549)***	-0.179 (0.053)***	-0.158 (0.056)***
$\%stim(-4)$		-0.023 (0.0546)***		
$\%GSP$	-9.83 (.804)***	-3.85 (0.678)***	-3.95 (0.696)***	
$\%GSP(-1)$		-2.95 (0.680)***	-2.79 (0.697)***	-3.32 (0.733)***
$\%GSPother$		-16.012 (1.802)***	-16.911 (1.66)***	
$\%GSPother(-1)$		-31.38 (1.694)***	-28.82 (1.653)***	-37.97 (1.57)***
$\%(def - stim)$		-0.049 (0.00575)***		
$\%(def - stim)(-1)$		-0.0114 (0.0064)***		
Constant	0.094 (0.013)***	0.196 (0.0122)***	0.237 (0.011)***	0.203 (0.011)***
Observations	1785	1785	1785	1785
Groups	51	51	51	51
R^2	0.0842	0.4412	0.4068	0.3426

Table 3: Regression Results

DISCUSSION

Upon running a panel regression across all 50 states, we find that all our chosen variables are statistically significant, thus implying that the Act was successful in curtailing the increasing unemployment rate. As we can see from Table 3, all coefficients are statistically significant even at 1 percent level. In our second model as well, we find that all our chosen explanatory variables are significant even at 1 percent significance levels. This gives us valuable insight and informs us that the variables that we have chosen as explanatory do have statistical implication on our dependent variable. The most important insight that this model provides us with is that the addition

to the deficit, due to the increase in the stimulus, was not statistically significant in increasing the amount of deficit for the given resulting change in unemployment rate.

The regression coefficient estimates indicate that an increase in the stimulus provided by 26 percent compared to the previous quarter decreases the unemployment rate by a percent. Moreover, the GSP is a much more effective tool as compared to the stimulus as expected with a higher coefficient value. This implies that a higher change in GSP was required to correspond to a similar decrease in unemployment rate. Finally, the increased deficit does not seem to affect the change in unemployment rate. These results indicate that our hypothesis holds and the increase in spending undertaken by the government was successful in reducing the unemployment rate following 2009.

We also constructed impulse response models for all 50 states in consideration (shown in the figures below is Alabama, a state chosen randomly). From the figures, we can infer that the maximum variation in the unemployment rate was caused by changes in GSP of neighboring states. We can also see that the funds awarded had a net negative impact on the change in unemployment rate. We can also see that for the particular case of Alabama the maximum decrease in unemployment rate was after 7 periods of the funds being awarded. On an average, the maximum decrease was around 4.3 quarters. The corresponding decrease was of -0.3 points.

Response to Cholesky One S.D. Innovations ± 2 S.E.

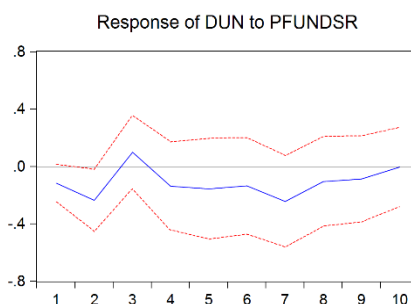


Figure 1. Effect of Stimulus on Change in Unemployment Rate

Response to Cholesky One S.D. Innovations ± 2 S.E.

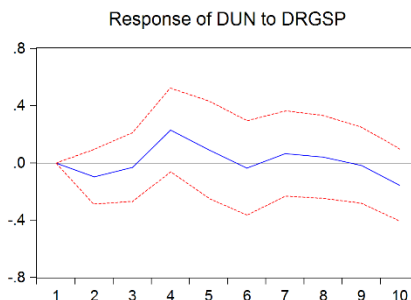


Figure 2. Effect of Gross State Product on Change in Unemployment Rate

Response to Cholesky One S.D. Innovations ± 2 S.E.

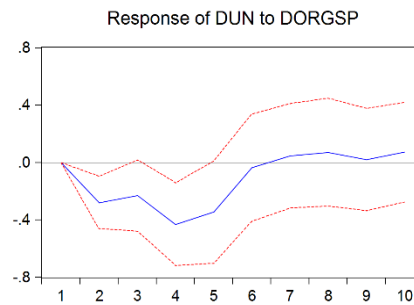


Figure 3. Effect of Neighboring State's Gross State Product on Change in Unemployment Rate

This analysis is in no way complete. The limitation of this model which has been worked upon includes lack of instrumental variables and assumptions of endogeneity. Other authors have used tax collected by the government on tobacco as a instrumental variables. However, since our analysis was on a quarterly basis, we were unable to find a similar instrumental variable. Another part of this analysis involves looking at a Chow test. We are currently working on that part of the analysis and will revise this paper once that it has been completed.

CONCLUSION

The housing market crash was the worst recession in the history of the U.S. since the Great Depression of 1930s (IMF 2009). The Federal Government's timely action of providing almost \$1 trillion in stimulus packages and the Reserves printing of \$600 million to maintain liquidity turned out to be beneficial to the economy. These bailout programs were successful in saving the economy from worse consequences and from deepening the recession.

The study successfully evaluates the efficacy of the American Recovery and Reinvestment Act of 2009 against its trifold objectives. In our analysis we have used a 8-year panel data set across all 50 states in the United States to find that the Act was successful in accomplishing its goals. We also find that an increase in government spending by 26 percent lead to a unit decline in unemployment rate at no statistically significant burden on the national deficit. We hope that this analysis will increase the efficacy of the implementable policy measures in the future.

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